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Owing to a multiplicity of causes, our Journal has not reached subscribers at the proper time. Among them, we may mention changes in our printing office, which have contributed to the present delay, but will enable us to afford still greater facilities for the future.

A large number of communications are on hand, and will appear as rapidly as possible.

Communications have been received from Messrs. Rockbury, Latrobe, Earle, Olmstead, Smith and Cushman, also, from Smeaton. We are much indebted for several very excellent articles, and have to apologise for the delay in presenting them to our readers.

We are also under obligations to Messrs. Fessenden and Schlatter, for valuable documents which have been kindly forwarded with great promptness.

We take great pleasure in presenting the following paper of Mr. *Roebling*, on the subject of Suspension Bridges. The labors of Mr. *Ellet*, have contributed to bring this matter into general notice, aup we are glad to find that other Engineers are turning their attention in that direction. No time can be more suitable for the discussion of Suspension Bridges, and we hope soon to see this class of structure coming into general favor.

For the American Railroad Journal and Mechanics' Magazine.

SOME REMARKS ON SUSPENSION BRIDGES, AND ON THE COMPARATIVE MERITS OF CABLE AND CHAIN BRIDGES.—*By J. A. Roebling, Civil Engineer. No.* 1.

The subject of suspension bridges is beginning to engage the attention of the profession. To cause public opinion to incline in favor of this species of structure, can only be accomplished by the

successful erection of some good specimens. The ocular demonstration they will offer, will advance this cause more than all treatises. Among the profession, however, this matter cannot be too much discussed, provided the discussion is carried on by men who are familiar with the features of the system.

The writer takes this occasion to remark that he has, ever since the introduction of suspension bridges upon the continent, made himself intimate with the system, that he had some excellent opportunities of becoming practically acquainted with the details of construction, and that he has, with devoted interest, taken notice of all the improvements which have gradually been introduced.

Chain bridges originated in their improved form in England, and were, in the course of a few years, introduced into France and Germany. The material of which the chains in most of these bridges are manufactured, is common iron. The bars, composing the links, are generally about 15 feet long, 4 inches deep, and three-fourths of an inch thick, therefore presenting a sectional area of 3 square inches.

The difficulty of insuring the iron in such dimensions of an uniform and even quality and strength throughout, is obvious, and hence the large quantity of iron expended in chains to insure strength and safety. The general practice has been to allow from 16 to 20,000 lbs. per square inch, as the maximum strain to which chains should be subjected in the most trying case. This is rather less than one-third of the actual strength of iron bars. A far greater allowance of strength is made for the suspension rods, which are more liable to be seriously affected than the chains. Experience and fatal accidents which have occurred to some carefully planned and executed suspension bridges have proved that the usual allowance of strength for the chains and rods is not by any means too ample. With the exception of some accidents which were the results of defects in the bars, and which only prove that the latter had not been sufficiently examined and tested, it can be shown that the most serious injuries to which suspension bridges may be subjected, can be guarded against more successfully by some alterations in the system, and by resorting to some simple expedients, than by a mere increase of strength in the chains.

On the occasion of the erection of several suspension bridges over the arms of the Danube, in the city of Vienna, a body of scientific Engineers undertook a series of experiments on the strength of different sorts of iron, steel and wire. The actual capacity of iron to sustain a powerful strain uninjured, does not so much consist in its ultimate tenacity as in its elasticity. A bar of good iron

may sustain a strain which approaches the limits of its strength without breaking, but a succession of such trials, which are beyond its elastic capacity, will gradually stretch it permanently, and cause at last a rupture.

Any strain upon a bar of iron, no matter how trifling, will produce an actual elongation of its fibres. Owing to the elastic quality of iron, the fibres will contract again as soon as the cause of the strain is removed. But this will only take place to a certain extent. The extent of the elongation to which the fibres may be subjected without having their power of contracting at all impaired, is the limit of elasticity on which we can safely rely. Therefore, iron should never be strained beyond this limit. This rate of elasticity in common bar iron amounts to about one third of its ultimate strength. If, therefore, thirty tons are required to break a bar of iron of one square inch, the strain it can support without injury, will amount to ten tons. If this strain is frequently repeated, and applied for a considerable length of time, it should be reduced to eight tons or even less.

The result of the experiments at Vienna was, that the Engineers decided in favor of steel as the material to be used for the chains; the elastic power of this metal, and the greater uniformity of its grain, being so much superior to that of iron, that greater strength and safety could be obtained for less expense by using it instead of iron. It is proper to remark here that the steel used in these bridges was manufactured of natural steel ore, and cost but little more than iron.

Note.—Natural steel ore is found in abundance in Austria, and in the famous mining districts of Seigerland, in Prussia. A few remarks on the Muessener mountain in the latter district may not be uninteresting to those who intend to visit the continent and the river Rhine, from whence they can easily reach the celebrated steel mine at Muessen. The steel ore has no resemblance to common iron ore, and looks more like crystalize feldspar than any thing else. The mine at Muessen where this ore is found in its greatest purity, has been worked since time immemorial, and it is computed, that when the ore is exhausted, the mere pillars, which are now left to support the roofs, will furnish a supply for many centuries more.

This mine is not worked in the common way, and has a remarkable appearance. The visiter descends a broad flight of steps, arched over at a convenient height to walk upright. Arrived at the floor of the gallery, he finds himself at the entrance of a mag-

Since these steel suspension bridges were constructed, wire cables in place of chains were more generally introduced by the French Engineers, and gradually prevailed over the whole continent.

The superiority of wire cables over chains cannot be contested for one moment, why the English Engineers still cling to the old system, after they have seen the principle of wire cables successfully tested, and particularly after they have witnessed the success of the Friburg bridge, which exceeds the Vienna bridge in boldness. Why, after so much experience, they do not abandon the use of chains, is to me truly a matter of astonishment.

The ultimate strength of wire as used in cable bridges, is two-thirds greater than that of iron bars as used for chains. The proportion of elasticity to the ultimate strength is greater in wire than in iron. 52,000 lbs. may be relied on with safety, as the extent of the elasticity of wire per square inch.

On the other hand, iron is much cheaper in the form of bars of several square inches section, than in the form of wires of $\frac{1}{8}$ inch thick. But the manufacture of wire cables is a great deal simpler and cheaper than the manufacture of chains. The cost of a wire cable bridge will generally be found less than of a chain bridge of the same strength. But there are some peculiar features belonging to the cable system which should decide in its favor even at an advance of cost.

The process of wire drawing, imparts to the iron a great uniformity of grain. If a strand is made of good iron, and sound at its ends, it is generally good throughout. Unsound places are mostly visible on the surface. The toughness of wire strands is easily examined by testing the two ends. The actual test of all the strands throughout can likewise easily be effected.

A cable is constituted of a great number of wires. Admitting now that a few unsound strands, in spite of all care and vigilance,

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nificient hall and succession of halls, with dome shaped ceilings supported by pillars. These excavations have been made in the solid ore, and the effect of the reflection of the light, when properly illvminated, from the millions of crystals of ore composing the walls, all around, is very beautiful and fairy-like. This sight is worth a trip of 100 miles to enjoy.

The South American market, and part of the West India market is largely supplied with all sorts of implements and cutlery, made of this natural steel ore.

[It may be well to remark that a similar ore is not uncommon in the United States. [Ed. R. R. J.]

should find their way into a cable, their number would be too small to affect the strength of the whole materially. All the single wires are coated with a durable varnish, and the finished cable is coated again, and may be effectually protected against the influences of the weather by a tight wrapping throughout. The wrapping has also the advantage of preventing the unequal expansion and contraction of the inner and outer wires, when exposed to the rays of the sun, and sudden changes of temperature. Cables can in this manner be more effectually protected against oxidation, than chains of bar iron. The beauty of a well manufactured cable is, that all the component parts are uniformly placed and equally strong throughout. Each single strand bears exactly its portion, and thus the greatest strength is effected by the least amount of material.

The floor of a chain bridge is suspended by vertical iron bars, in cable bridges these suspenders are formed by small wire cables, which should always have an inclined position. Even where a chain bridge should be found preferable to a cable bridge, the suspenders should be invariably made of wire. Wire suspenders are pliable, and will easily move with the floor, when set in motion by the wind. The fastenings of the suspenders at the two ends cannot give away; but it has frequently occurred on chain bridges, that the heads of the suspension rods have been snapped off in consequence of the wresting and twisting.

I will notice here the remarks of Colonel Pasley upon the effect of storms, communicated in the Transactions of the Institute of Civil Engineers:—

"By the hurricane of October 11, 1835, one-third part of the roadway of the Suspension Bridge at Montrose (410 feet span,) with a very small exception, was carried away. The suspension rods on the west side were either broken or very much bent, but the chains, 4 in number, and extending in two parallel lines, of two tiers each, appeared perfect. It is our opinion, based on observations, that the motions which a bridge experiences, are not *lateral*, but *longitudinal*. The Hammersmith suspension bridge does not appear to be subject to these longitudinal motions, even in a most violent gale, and this is amply accounted for by the longitudinal trussing which is there adopted. The idea, that these longitudinal motions, and the injuries to the road-ways of suspension bridges, are owing to the violent action of the wind from below, is confirmed by what Colonel Pasley witnessed in Nov. 1836, at the Chatham Dock Yard. One side of the roof of a shed for ship building, was raised up and down repeatedly, until at last, a large portion of it, about 40 to 50 feet, was floated up like a sheet of

paper, and carried to a distance of 50 yards. Such being the violence of the wind, we may readily conceive that the continual extension and compression to which the suspension rods must be subject, by the rise and fall of the road-way, is prevented in the Hammersmith bridge, by four lines of strong trussing along the whole length of the road-way, firmly connected to the bearers below. No similar trussing exists in the Menai, the Montrose, or any other suspension bridges which Colonel Pasley has seen. The rise and fall of the platform of the Menai bridge is confidently stated to be three feet in ordinary gales, so that unless some similar trussing be employed, it may reasonably be expected that this bridge will be seriously injured in some future hurricane. The peculiar construction of the suspenders in several pieces, with joints, is a source of security to this bridge which the others do not possess. The author believes that no suspension bridge of 400 feet betwixt the piers can be considered secure without two inflexible lines of longitudinal trussings from pier to pier."

For the American Railroad Journal and Mechanics' Magazine.

PRESERVATION OF TIMBER.

The following is copied from an *informal* report made by Mr. R. M. Bouton, the intelligent director of the "process" for the U. S. ordinance department, at the Watervliet arsenal, N. Y.; where, during the last summer and autumn, he has been employed in preparing a large quantity of timber for the public service. The *official* report, intended to be made, being delayed by the unfinished state of some experiments thought necessary to its completion; these facts and inferences are given in anticipation, by Mr. Bouton, with full assurance of their general correctness.

1. That the cost of the process, embracing the mineral salts, labor, and fuel employed, need not exceed a half to two and a-half cents per cubic foot of timber; varying with circumstances which need not be here particularized.

2. That different kinds of timber receive the benefits of the process in different degrees of facility and time; the latter extend-tending from 24 or 48 hours to 3 or 4 days, or more.

Chestnut, hemlock, black walnut, ash, elm, oak, birch, hickory, maple, white wood and pine, are affected by it with variations of time and facility pretty much in the order in which they stand.

3. That the *density* of the wood is evidently increased; yet that it works well, and without injury to tools.

4. That *toughness* is also decidedly increased in ash, elm and hickory, (as actual employment of these woods at the arsenal has

already proved); and, by inference, that other kinds of lumber will be similarly affected.

5. That the *strength* also of the three kinds, just specified, is certainly increased; affording a legitimate conclusion in favor of others.

6. That the effects produced on green and seasoned timber are not ascertained to be importantly different.

7. That, in short, *all* the sensible manifestations of timber, thus treated, indicate very important improvement; which is confirmed by the use of several, as already stated; while no evidence whatever is afforded of deterioration, or of diminution of any valuable property."

To these specifications, Mr. Bouton adds his unreserved opinion that "this process will be proved, by experience, fully equal to the purposes intended."

It is gratifying to be able to add to other evidences, long before the public, in favor of this process, the testimony of this gentleman so well known for his intelligence, and cautious and correct observation. And, as connected with the above, I would refer for other strong testimony on the subject, to the No. of this Journal for January 15th, p. 53.

EDWARD EARLE,
Phila. Feb. 27, 1841.

☞ The improved apparatus, which I have lately adopted for the process, may be constructed to suit any purpose, and of various costs—from $75 to $250; the last of which is equal, with suitable tanks, to the preparation of 2000 to 3000 cubic feet, at an operation.

For the American Railroad Journal and Mechanics' Magazine.

February, 1841.

In a late number of the Journal, I observe an attempt by "Fulton," to reduce to something like a uniform plan, the future prosecution of improvements within the State. Whether that he proposes be the very best that might be propounded or not, I think it must be admitted to be, in itself a laudable effort to do what is very much needed; and that, at lest, most of his suggestions and provisions are judiciously conceived.

It is very evident that Fulton's bias is strongly in favor of railroads in preference to canals,—a subject of which, in the phrase of good Sir Roger, "much might be said on both sides;" and then, probably, it would be agreed, by compromise, that neither the one nor the other but that both are best. So I think. But however this

may be—many canals are already constructed, especially in our own State, and are very efficiently doing their duty. They therefore must be maintained; but if experience has taught that railroads are, on the whole, to be preferred, we shall not be wise in neglecting its lesson in our future undertakings. That the State should be a stockholder in every railroad, and should exercise, in many respects, a chief agency and controling influence, is a prominent position of F. and is urged with force. Much expansion might be given to the few strong reasons to which he has confined himself; and his doctrine is, in the main, so sound that I would hold to it under State-exigences much more considerable than those which exist. In the view, indeed, we are permitted to take of our financial condition—especially, if we make that view prospective—there can be no hesitation in admitting both the policy and prudence of the State's extending liberal aid to every such undertaking that promises a fair result. These modes of intercommunication between distant points of the State, and of intercourse and connection with other States, are fraught with advantages of which experience, hitherto, has given us but a glimpse;—of which it is hardly possible, indeed, to form a sober-seeming estimate. In my own anticipations of their importance and productiveness I might suspect myself of overstepping good discretion, were I not sustained—it might be more proper to say prompted—by the example of Governor Seward in his late message to the Senate and House of Representatives. In that able and Statesmanlike paper, of which it is difficult to determine whether intelligence or benevolence,—the soundness of his head or the goodness of his heart—is the prominent feature—his excellency has traced a view of our future prosperity, and internal commerce as unlimited almost as the west itself—whither he directs it.

If the revival, he seems to think at hand, should come indeed, and bring with it a "distribution of surplus revenue" from the sales of our national territory,—what advantages and blessings may we not expect from the judicious appropriation of them to such objects as he has recommended!—of these, internal improvement is a principle one; which already is becoming paramount to most others. The present and succeeding years are likely to be busy in such work; for the spirit of improvement has gone forth with an impetus not likely to be arrested, and will receive fresh vigor from the constant succession of its own accomplishments; for our country, extensive in territory and rich in various wealth, presents so broad a surface and so many excitements to the industry and enterprise of its possessors, that it were a sort of "sullenness against nature" not to avail ourselves of her overtures;—and such is not our character. It is a

fact however, which ought not to be passed without remark, that our public works have been executed with less regard to permanence than there is reason to believe they might and, if might, they certainly ought to be.

Already pretty largely a contributor, and likely to be more so,—to those improvements, and prompted by more than selfish feelings to desire their progress and success,—I will here suggest, as supplementary to "Fulton," what ought to be, if practicable, a part of every such undertaking in order to secure to them a continuance of public favor.

Next, in importance, to the construction of a canal or railroad at all, should be the care to secure its duration;—that it be so done and with such materials, that the outlay be not lost in early failure from delapidation or decay. For it is a maxim worthy of general acceptation, that what is worth being done is worthy of being well-done. To this purpose, therefore, whether the work be a canal or railroad—the timber to be used in the construction should be selected with judgment; and this should be one of the earliest provisions of the company, that it may be as thoroughly seasoned as possible before it is subjected to the destructive alternations of the weather in its destined positioni and become, as it generally does, the most active consumer of those profits which, otherwise, might constitute a most satisfactory dividend to the stockholders. Nor, if there be any scientific mode of treating it to insure its duration, that can be relied on, ought it to be neglected, unless, indeed, the cost of such treatment be more than commensurate with its advantages. Other occupations have compelled inattention to this matter; but I collect from occasional notice of them in the Gazettes, as well as from the "Railroad Journal," that there are several well-accredited methods of accomplishing this very desirable purpose, and that one of them is being extensively employed by the war department at the Watervliet Arsenal in this State. This would imply a preference of it by that department—whether for efficiency or economy or both might be easily ascertained, and deserves inquiry by those whose appropriate duty it may be. Effect and ecomomy being the motive of preference, I would propose that the State (supposed to be already a Stockholder according to the suggestion of "Fulton,") authorize an inquiry into it by a competent person, and also bear such share of the expense of employing it as shall be equal to its interest as a stockholder, viz., if one-third, then one-third, etc., and to insure to the timber the full benefit of a proper application of it, that the same competent person be appointed by the State to direct and su-

perintend it. This would relieve the individual stockholders of much of the expense, while, to the State, it would be annihilated by being only an extension of the right it may be supposed to have acquired for the use of the process on works wholly and exclusively of the State. If timber may, by such means, be made to endure two, three, or perhaps four times as long as otherwise it would, and at an expense of one-sixth or one-eighth of its first cost, as is represented—would the State, as a stockholder, consent to forego so great advantage, or an individual decline his proportion of a charge to be returned to him in, often, multiplied amount?

This is altogether deserving early attention, that the advantages of such a method, if it be ascertained to exist, may not be lost to those works which are now in progress and about to be. Nor can I conceive a more judicious appropriation that the State could make than of such a sum as may be supposed necessary to secure the right to use it as here suggested. One other particular I will advert to as I have not seen it recommended before, which, also, ought to be subject to the control of the State; and that, of all railroads henceforth to be constructed, the tracks should be of a uniform width. The conveniences resulting from such agreement are too obvious and multiform to require enumeration. But this suggestion is offered on the presumption that the State becomes, as it is greatly to be hoped she will, a party to all future constructions of this kind.

PHILO FULTON.

CHATHAM CENTRE, *Columbia county, N. Y.*
January 26, 1841.

To the Editors of the American Railroad Journal, and Mechanics' Magazine.

GENTLEMEN:—I would say a word about a communication that appeared in your Journal of the 1st October, signed by J. E. B., relative to the cost of depots and grounds for railways.

Your correspondent, J. E. B., either misunderstands the reports of the engineers of the (Mass.) Western R. R. or he has not paid enough attention to it. He says, "The Western R. R. Co. of Mass., over the mountains and rocks of Berkshire, have paid at the average rate of $1700 per mile, or about $200 per acre," and adds that the general width of railroads is 4 rods or about 8 acres to the mile.

The laws of Mass. alow R. R. companies to take 5 rods and they always do take 5 rods, even when the grade of the railroad runs along on the surface of the ground—thus making about 10 acres to the mile. Again, the Western R. R. is nearly as often *fifteen rods* wide as 5 rods, in Berkshire county—varying from 10 acres to the mile to 30 acres.

You see that I am reducing Mr. J. E. B's $200 per acre, pretty fast; but I have not done yet—to proceed—

The report of the engineers does not separate Berkshire county from the rest of the line west of Springfield in the average cost per mile of the land—consequently it is hardly fair to take the average cost per mile of their whole western part of the line, which is very much raised by going through many valuable farms nearer to Springfield, and apply it to the "mountains and rocks of Berkshire," besides, when a railroad passes through such a large and thriving town as Pittsfield, the average rate is raised considerably, and a railroad in Mass., goes through a more thickly settled country, land more valuable for building lots, manufacturing and other purposes than the wide spread territory of New York. Again—the $1700 per mile includes the cost of *land*, the *building and keeping in repair fences*, *moving buildings* and a few other items. About $600 per mile should be allowed for fencing and keeping it in repair—from 90 cts. to $1 per rod. Between Springfield and Chester, a distance of 30 miles, no less than *twenty-eight* buildings were moved—other instances might be given where buildings were moved at a great expense.

I think, Messrs. Editors, that the actual cost of the land—(land only)—may be set down a considerably nearer $2 per acre than $200—two than two hundred.

For the American Railroad Journal, and Mechanics' Magazine.

A BRIDGE AT THE FALLS OF NIAGARA.

Messrs. Editors:—On visiting the Falls of Niagara, much as the mind of man is struck with astonishment and awe at the vastness and sublimity of the scenery, at, and in the vicinity of the "thunder water," the magnificent and indescribable work of nature: he feels not a little surprise and admiration in viewing the power which his own species has displayed in constructing a safe and permanent bridge over a very considerable and rapid portion of the cataract from the American shore to Goat Island.

A person who has never been engaged in such constructions, marvels much at the success of that undertaking, and leaves the scene, under the impression that the work must be the *ne plus ultra* of bridge making, and retires, satisfied that he has seen and passed over, probably, the most extraordinary viaduct in the world. The ambitious engineer, or bridge architect, however, investigating the plan, which was put into successful operation at that point, examines

other places in the vicinity, to find whether he could not construct a rival work, the very existence of which would carry his name down to the most remote posterity. Forgetting the romance of the mighty cataract, he contemplates the hydrostatic power which it presents. He sets imaginary water wheels in motion, five hundred feet in circumference, and in his mind creates a poetical saw mill with power sufficient to cut the British possessions into small scantlings. He looks forward to the time when manufacturers will erect machinery sufficient to employ every drop of the waterfall, (as they have already almost done at Rochester) and two populous cities spring up on the opposing shores, rivaling each other in metropolitan magnificence. He is now employed by air-created, town council's as engineer of the cities, and required to build a bridge across the Niagara river above the awful abyss! But how in the name of wonder can this be done?

Indulging in this species of castle, (or rather) *bridge* building, on a recent visit to the Falls, a plan occurred to me, Messrs. Editor, which carried out, I am very certain, would accomplish this apparently monstrous undertaking, and piers of a bridge could actually be erected on the very brink of the horse shoe precipice.

To effect the object, I should proceed as follows :—

On the smooth water, as short a distance above the rapids as possible, I would endeavor to find a point where both shores are precipitous—and at this place I should build a sort of wharf-like abutment of timber and earth on both sides of the river, and opposite each other. I should then construct a number of *caissons* on the shore, in such form as that they might be joined together in regular concatenation, and fit each other at the joints so as to be water tight. The lower part of the chain of *caissons* should be formed so as to fit as nearly as practicable the bottom of the river on a line between the two abutments above mentioned. I should now launch these structures into the stream, and floating them to their destined position, sink them for the purpose of forming a temporary dam across it.

Previous to the above operation, I shall have procured and prepared materials sufficient to raise the piers of my bridge above the reach of the water of Niagara, and also to erect centering for the arches of such a character as would not be interfered with on the current. These preparations having been made, the shortest time in which the piers and centering could be erected by a force applied to it. Night and day should be calculated, and then the Niagara river should be gauged with the utmost accuracy.

I should now ascertain, the superficial area of lake Erie, and also the areas of planes parallel to it, bounded by the shores, but 1, 2, 3, &c., to 6 feet higher than its present surface; and taking the quantity of water which falls at the great Niagara leap; discover by calculation, the height which that quantity, falling into the lake would raise it above its present level, during the time which would be required in the erection of the piers and centering. To this height, I should raise the temporary dam, and then proceed with masonry at the Falls.

Supposing the dam to be constructed, and made nearly water tight, the water below it would very soon disappear over the precipice and leave the bottom of the stream comparatively bare, at least sufficiently so not to interfere with the operations. Against this plan there might be an objection urged, that raising the lake would very materially damage buildings, storehouses, wharves, etc. at other cities erected close to the waters edge, and possibly the Erie canal below Buffalo might be interfered with. But it appears to me, without, however, having made any calculation that it would require at least four weeks for the natural supplies of Lake Erie to raise it four feet, (a period amply sufficient, with skilful engineers and mechanics to complete the operation required) and there is scarcely any part of the shore of Lake Erie which I have seen, where so small a rise upon previous notice having been given, that it would take place, could be productive of serious consequences.

The whole project, you will perceive, Mr. Editor, is given vaguely and with no particular data whereon to base minute calculations. The principles on which it could be carried into effect, are all that is necessary to set forth at present, in order to convey an idea of its practicabilities.

Very extensive and minute surveys of the lake shore, should, of course be made, and, also, calculations of probable damages and other estimate of the cost should be gone into. I merely submit the project to your readers as a matter of amusement, for the time at which such a work would be needed is too far distant to require us to consider the subject with any other motive.

At a half-hazard guess I should estimate the cost of a permanent shore bridge, *erected on a line tangent to the horse shoe Fall of Niagara*, from the British shore to Goat Island—including surveys and all other contingencies—at one million, five hundred thousand dollars.

SMEATON.

West Greenville, Pa. Jan. 1841.

DESCRIPTION OF A NEW FORM OF EDGE RAIL, TO BE CALLED THE Z RAIL, WITH ITS SUPPORTS, FASTENINGS, ETC.—*Making with it a part of a railway track of a new construction—With estimates of the strength and stiffness of the rail, etc.—and of the cost of the track—and a comparison of it in these particulars, with other forms of railway.*

The undersigned solicits the attention of his professional brethren, and of others interested in the improvement of the railway, to what he presents under the above head. Although great progress has been made in the advance of this important structure towards perfection, under the impulse which it has received from the united talents and industry of the body of Engineers and Mechanics, who have been for the last ten years emulating each other in its improvement, still, it must be confessed, that perfection has not yet been reached. Daily experience upon the best railways of Europe and America, exhibits defects for which remedies are sought in each successive new work that is constructed. In laboring, along with the rest of his profession, to detect and remove these imperfections, the undersigned, in the range of thought which these efforts involved, has had presented to his mind the novel idea which he now offers, and which appears to him to be entitled to be regarded as at least a further step in the course, if not an arrival at, the goal. He is aware that the railway, like every other machine, having a single object in view, is yet capable of assuming a variety of forms, all of which may in a measure, produce the desired result. It is, however, no less true, that among these forms, one must be better than all the rest, and to it its competitors must ultimately give away. Among the T, the H, and the inverted ∩ or Bridge rails, one would at last supersede its fellows; and the course of things is already tending fast to a selection and preference of one of the three. The question being, upon which does the choice promise to light, the undersigned would venture the opinion, that it will fall on the last of the three;—not because it is theoretically the best form of section, but because it will wear the best in its practical use—on account of its better supported top, and the greater spread of its base, and the greater facility it affords for making the joinings good. But supposing the question of the best form of iron rail settled, as between the three sections just mentioned, in favor of the Bridge rail, the best manner of *supporting* it comes up still for decision; and herein the opinions of Engineers will find room for many differences. Some will advocate the entire rejection of timber, and others its very free employment, in the substrurture of the track. In the first of these extremes, the English Engineers were, until recently, to be found; but they are now becoming aware of the great value of wood as a component part of the railway structure both for the means it affords of making it a connected piece of *framing*, and for the relief from concussion and jar, which its elasticity yields to the machinery and to itself. These excellent properties are beginning to be justly esteemed as more than a full compensation for the perishability of timber; and since the profession in Great Britain, where durability in all public works is so highly prized, and aimed at in total disregard of first-cost, is showing this disposition to patronize this perishable material, from a conviction of its superior advantages in other respects, it may be, it is thought, fairly inferred from present appearances, that the *wood* and iron will supersede the *stone* and iron railway. Looking, then at America, a glance at the railways of *New* England, where expense of construction has been, as in *Old* England, but lightly regarded in comparison with economy of *repairs*, confirms the inference just drawn; for upon but one of the railways of the Eastern States are

stone supports employed, and that one of the earliest opened in that section of the Union.

This general conclusion in favor of timber being admitted, there are still important questions open respecting the details, and the first of them is, whether the wood should be so disposed as to give the rail a *continuous bearing* or not. And it is apprehended that this point will not remain long in dispute, and will be decided in the affirmative; for it can be shown that the continuous bearing does not necessarily involve the use of more timber, (in obtaining equal strength of structure,) while it gives great additional support to the rail against all the strains to which it can be subjected. Starting, then, from this last point, even if it be a little in advance of *unanimous* professional opinion at this moment, the undersigned offers his new form of rail, to which the continuous bearing is *necessary*, without much fear that it will *on that account*, be condemned in its comparison with sections of rail to which such a support is not absolutely essential.

DESCRIPTION, ETC.—The accompanying drawing exhibits the plan in its details, allowance being made for the following modifications, which have recommended themselves for adoption since the drawing was printed, viz:—The rail, string piece and undersil are made 21 instead of 18 feet long—the string piece is sunk 1 inch instead of $\frac{7}{8}$ into the cross-tie, and the foot of the rail descends $\frac{3}{8}$ of an inch into the tie, instead of resting on its upper surface.

The Track now described, will consist of the longitudinal under-sills, (a, a) 3×10 inches in the section, with cross-ties (b, b) $3\frac{1}{2} \times 6$ and 7 feet long, placed upon them at intervals of 3 feet from centre to centre, and upon the cross-ties notched 1 inch deep to receive them, will rest the string pieces (c, c) (of the trapezoidal section shown) 3 inches wide at top, $5\frac{1}{2}$ at bottom, and 5 inches deep. A treenail $1\frac{1}{4}$ inches diamater, is driven vertically through the 3 timbers at each cross-tie, excepting the ties on which the string pieces join, where there are two treenails of 1 inch diameter. Both under-sill and string piece are 21 feet long, and break joints with the rail, (also 21 feet long) and with each other. The section of the rail (d, d) resembles the letter Z, the head or upper table being turned to the one side of the stem, and the foot or lower table to the opposite side. The rail is placed against the inner side of the string piece, with the upper table lapping over the upper and inner edge of the string piece, and thus bearing on the *top* of the latter; and the lower table resting upon the cross-ties notched down $\frac{3}{8}$ of an inch to receive it. A continuous top bearing on the string piece, and detached bottom bearings on the cross-ties, are thus obtained. The rail is held against the upright inner side of the string piece by horizontal screw bolts (e, e) every 3 feet, which pass through the stem of the rail about midway between its top and bottom, and through the string piece; the head of the bolt bearing against the rail, and the nut, with a thin washer, against an open morticed seat in the outer slope of the string piece. These bolts (being 9 to each bar of 21 feet) are placed at points midway between the cross-ties, excepting the two in each bar at its end, which come over the cross-ties on which the joints of the rail occur. The rail is further confined laterally at its foot, by the shoulder of the notch into which it descends, and also held down by a hook headed spike (f, f) driven vertically into each cross-tie. At each joining of the rails, a cast iron joint plate (g, g) is let into the cross-tie, to increase the bearing of the rails at these weaker points; this plate having on the outside a ledge to confine the feet of the rails, and two holes in it to permit the spikes lapping over them, to be driven downwards into the tie. The track thus constructed, will rest on a bed of broken stone, sand or gravel ballasting, 10 feet wide

at bottom, 8 feet at top, and 12 inches deep, which will be filled up to the top of the cross-tie, and 1 inch above the bottom of the string piece, and leave a depth of $5\frac{1}{2}$ inches below the under sill for drainage, etc.

The rail is intended to weigh 45 lbs. per yard—its whole depth is 5 inches, thickness of stem $\frac{9}{16}$ of and inch—top bearing for the tread of the wheel $1\frac{1}{2}$ inches, total breadth of upper table $2\frac{1}{4}$ inches—breadth of bearing of upper table on the string piece $1\frac{1}{2}$ inches—breadth of foot inclusive of stem $1\frac{9}{16}$ inches—the whole breadth of the upper and lower bearing surfaces $3\frac{1}{16}$ inches—bolt hole in the stem $\frac{1}{8}$ of an inch diameter.

The proposed rail, and the structure of which it is a part, will admit, of course, of a variety of proportions. The forms and sizes of the several parts shown in the preceding description and annexed drawing, are considered suitable and sufficient for a track intended for the heaviest tonnage and highest speeds. It is hardly necessary to say, that the rail and its fastenings, in combination with the string piece and cross-tie, form the only subjects of claim to invention; as the under sill, ballasting, attachment by treenails, and even the trapezoidal form of the string piece (for economy of timber) are none of them new elements of the railway structure.*

ESTIMATED STRENGTH AND STIFFNESS OF THE RAIL AND COST OF THE TRACK.—In calculating the load and deflection of the rail and string piece, the well known, formulæ of Professor Barlow, contained in his excellent work on the strength of materials, published in 1839, have been employed; and as they are based upon correct principles of mathematical analysis, skilfully applied to carefully conducted experiments, they are entitled to the confidence of the profession.

The strength of the rail, for a bearing of 30 inches (taken at the *clear* distance between the cross-ties, which are supposed to be 3 feet from centre to centre) is ascertained by the rules just mentioned to be $8\frac{6}{16}$ tons; or in other words, this is the load which the rail will sustain at the middle of the bearing without impairing the elasticity of the iron. From this, however, will be deducted the fraction of $\frac{9}{16}$ of a ton, to compensate for the effect of the bolt hole in the bar (an ample deduction) and the strength will remain equal to 8 tons. This last is about 15 per cent. (considered, and correctly, by Barlow, to be sufficient) beyond the *double* of the mean strain which the bar will be subjected to, assuming that strain to be $3\frac{1}{4}$ tons pressing through a single wheel. The strength of the string piece, regarded as a rectangular beam of 5 inches deep and 4 inches wide, is found from the formuæ of the same writer, to be $2\frac{411}{1000}$ tons, which acting with that of the rail, makes a conjoint strength of $10\frac{411}{1000}$ tons. This quantity of $2\frac{411}{1000}$ tons, does not indeed represent the full strength of the string piece (or what it would bear within the limits of its elasticity) but merely the additional weight applied to the middle of the rail (and through it uniformly, or nearly so, diffused over the string piece) which would be necessary to bend the string piece under the rail, as much as the rail itself will bend under the

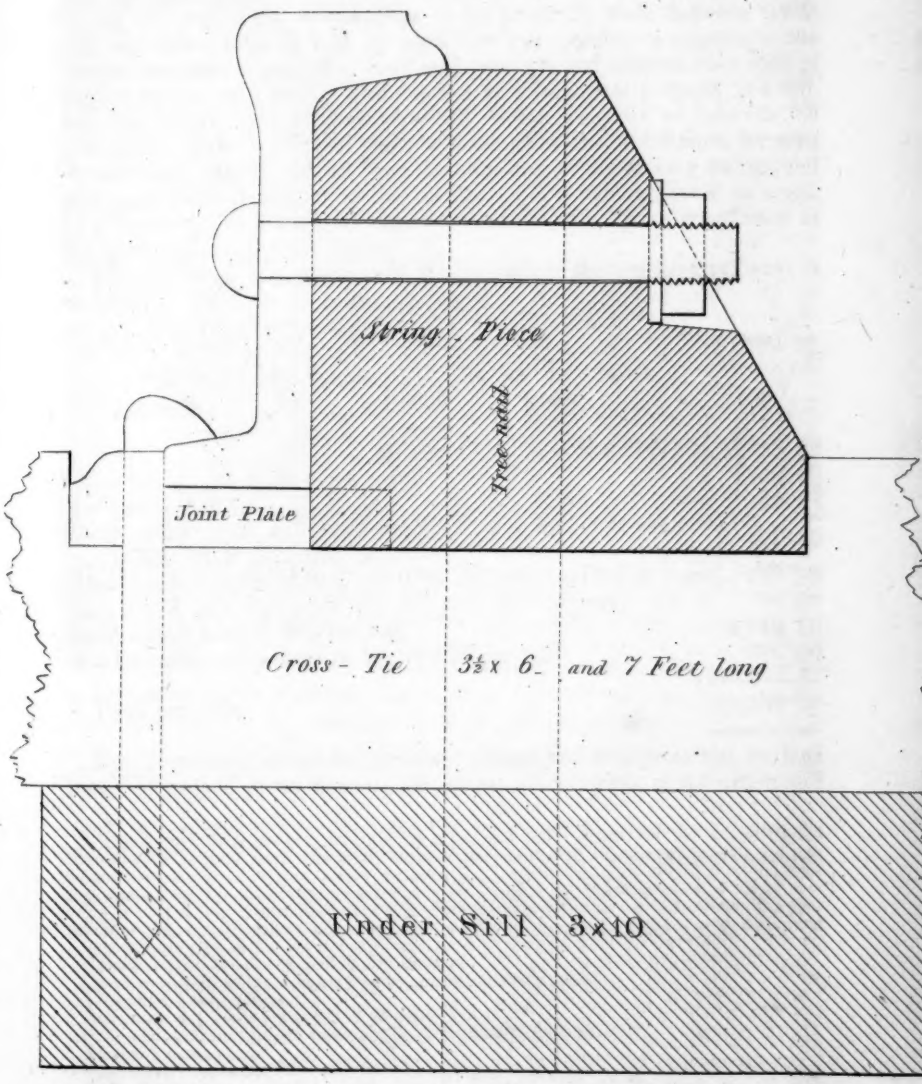
* The rail as shown in the drawing, has a slope given to the under side of the upper table, in order to make it a little stronger in its connection with the stem. This makes a corresponding slope in the part of the top of the string piece, forming the seat of the rail. The inclination (though not at all essential to the plan,) is not enough to do any *harm*; as the *friction* of the wood and iron would suffice of itself to prevent *sliding*. The sloping seat of the rail may be easily and quickly prepared, and the corner of the string piece rounded, by a planing tool with a properly shaped cutter. It is well known to be necessary to dress (generally with an adze) the top of the string piece for the common plate rail, to amend imperfect sawing. The string piece of the Z rail will be readily sawed into its trapezoidal form at the mill. The open mortice forming the shoulder of the nut of the screw bolt, will be cut so as to *drain itself* of water falling into it. The treenail head may be caulked and pitched, to keep the water out, or driven obliquely so as to put its upper end under the top of the rail. In other details of construction, improvements may perhaps be made upon the plan now presented, retaining its general features.

Z. RAIL

HALF SIZE DRAWING

of the Cross Section of

Rail, String-Piece, Cross Tie, Under-Sill &c



Lith. by E. Weber & Co. Baltimore

above weight of 8 tons. The rail and string piece, therefore, together form a beam capable of supporting nearly $10\frac{1}{2}$ tons for an indefinite time —a degree of strength much more than sufficient for every possible exigency.

The deflection of the rail alone, under the above load of 8 tons, will be .035 or $\frac{1}{29}$ part of an inch, but combined with the string piece it will be but .027 or $\frac{1}{37}$ of an inch; for as a load of $10\frac{41}{100}$ tons is necessary, as just stated, to produce the former deflection in the rail and string piece acting together, so a load of 8 tons (the assumed maximum) will produce in them only the latter deflection. These results exhibit a very stiff, as well as strong rail, and in the comparisons to be presently made between the Z rail and other rails, it will be seen how considerable an advantage the former possesses in regard to combined strength and stiffness over rails of similar weight with itself. Stiffness is a very important property in a rail, more so, indeed, than *ultimate strength*, which is seldom or never called into action, as the rigidity of the bar diminishes the deflections between the supports, which subtract from the efficiency of the moving power, and give more vertical motion to the machinery. A rail supported on wood, let it be as stiff as it may, will have a sufficient relief from concussion in the compressibility of the timber.

The *estimated cost* per mile of single track of the proposed railway, is as follows: the scale of prices contained in the subjoined note being applied to the several items of material and workmanship.*

Ballasting, 1,725 perches of 25 cubic feet, at $87\frac{1}{2}$ cents,			$1,509 37
Under sills, in 21 feet lengths, 26,400 feet board measure.			
String pieces,	do. 19,800	do.	
	46,200	do. at $25 per M.	1,155 00
Cross-ties, 1,760, at 20 cents each,			352 00
Tree nails, 4,024,	1 do.		40 24
Screw bolts, nuts and washers, 4,527, weighing $\frac{3}{4}$ lb each= 3,335 lbs. at 12 cents,			407 40
Hook headed spikes, 4,024, wg. $\frac{1}{3}$ lb. each=1,341 lbs. at 9 cts.,			120 69
Joint plates, 503, wg. 3 lbs. each=1,509 lbs. at $4\frac{1}{2}$ cts.,			67 90
Rails, $70\frac{71}{100}$ tons, at $70 per ton,			4,949 70
Workmanship of laying track, at $2,75 per rod,			880 00
Total per mile,			$9,482 30

No allowance is added for turn-outs, sidings and road crossings, such as would be proper in an estimate for actual construction, as the extent and

* The following prices are assumed as a fair and full average for the whole United States, at the present time. In many parts of the country all the materials specified can be procured at cheaper rates; but on the other hand, there are many districts in the interior where they will cost more, on account of the expense of transportation, want of saw mills to cut the timber and other causes of enhancement of price. At all events, the operation of the present scale of prices will be impartial in the comparisons of cost contained in the tabular view of the several railway structures exhibited further on—

Sawed timber, $25 per M. feet, board measure.
Cross-ties, from 20 to 45 cents a piece, according to the size.
Tree nails, 1 cent a piece.
Ballasting, $87\frac{1}{2}$ cents per perch of 25 cubic feet.
Screw bolts, from 12 to 16 cents per lb., according to the size.
Spikes, 9 cents per lb.
Castings, $4\frac{1}{2}$ cents per lb.
Rails, $70 per ton.
Workmanship, from $2 62½ to $3 per rod, according to plan of track.
These prices including delivery and distribution of materials along the line of road, ready for use.

cost of these accessories must depend upon the special circumstances of each case.

The statements exhibiting above the strength and stiffness of the rail and string piece, and the view of the general stability of the track afforded by a scrutiny of the plan as shown in the preceding descriptive drawing and estimates, and in the subsequent comparative table, will, it is believed, satisfy others, as they have the undersigned, that no line of railway, however great its business, will be likely to require a structure of *greater* strength than the one here presented. There may, however, be lines of lighter business, for which a lighter construction would answer; and in reference to such, the undersigned would express a belief, that a rail of the form he proposes, and weighing not more than 35 lbs. per yard, would form, in combination with the timbers of the present plan, a track of abundant strength.* Such a reduction in the weight of the rail, and an appropriate corresponding diminution in that of the fastenings, and a small one in the cost of workmanship, would (all other things remaining as above) leave the cost of the track $8,176 per mile. If, in addition, however, to these curtailments of quantity in the materials just specified, we reduce, as we may for many localities, (especially in the sandy districts of the seaboard) the cost of ballasting to 37½ cents per perch, and that of lumber to $18 per 1000, cross-ties to 17 cents, and workmanship to $2,50 per rod—the cost of the modified plan per mile, would be but $6,897.

The plan and probable cost of the proposed new track having now been fully exhibited, the undersigned proceeds to speak of the advantages which he believes it offers, and by which he hopes it will recommend itself to the favor of those whom he addresses. And in respect to the comparisons with other plans which follow, he begs permission to assure the eminent engineers who originated them, that he means not to detract, in the smallest degree, from the merit which belongs to their design and execution; but on the other hand, fully acknowledges his own obligations to them for the services which they have severally afforded him in maturing his own invention. Indeed, the new idea which he now presents to the profession, is but the offspring of his studious consideration, and comparison with each other, of all the forms of railway structure known to him; and it will be seen that he, (without intending to apply to himself, the language above addressed to his professional brethren,) includes the work which he himself projected and constructed (the Baltimore and Port Deposit railroad) among those in which there exists room for improvement. And in making this general acknowledgment, he is happy to offer a more particular one of indebtedness to his friend, John Edgar Thompson, Esqr., chief engineer of

* The rail thus reduced in weight, would have a head and foot nearly as heavy as the 45 lb. bar, but its stem would be reduced to ½ inch in thickness, and to 4 inches in total depth. The strength of the rail alone would be then, for a 30 inch bearing, 5.72 tons, with a deflection of .060—and the united strength of rail and string piece with that deflection, would be 9 85-100 tons, which, indeed, falls but little short of the similar result, with the 45 lb. rail. The reason of this is, that the greater deflection of the 35 lb. rail permits the timber to be strained to the full limit of its strength—which the stiffer 45 lb. bar would not allow. The advantage then, of the heavier rail is, that of the total strength of rail and string piece, the rail constitutes 76 per cent. while the lighter rail contributes but 58 per cent. to the aggregate strength of itself and the string piece. It is obviously desirable, that the least perishable material (viz. the iron bar) should possess the larger share of the united strength. Heavy timbers will give great strength with short bearings, and this is the kind of strength which the plate rail track may possess, but it will not compensate for the want of stability and stiffness in the iron bar; and the best proportion between the wood and iron of a track is, that in which the wood has just bulk and weight enough to give sufficient bearing surfaces to the *rail and its fastenings*, to prevent the crippling of itself under the strains to which it submits. In the Washington Branch, and Baltimore and Port Deposite Roads, there is more timber than is necessary, (see the tabular comparison below) and hence the excess of strength in the rail and spring piece, shown in the ninth column of that table.

the Georgia railroad, from whose ingenious suggestion of a T rail, with its stem confined between two string pieces bolted horizontally together, he first derived the idea of the Z rail and its accompanying support of timber.

The following is a brief enumeration of the particulars in which the undersigned considers his new rail an improvement upon the previous forms of the edge rail :—

1st. The lateral support given by the string piece to the rail, aided by the lateral strength given to the stem of the latter by the foot or lower web, permits the bar to be made thin and deep without the danger to which the stem of the T rail is subject, of buckling, or bending sidewise, under vertical pressure. Greater strength and stiffness is thus attained in the Z rail, with a given weight of metal, than in the plain T rail—and also than in the H rail, or Bridge rail; for in both of the latter sections, the width necessarily given to the base, for stability of position on its support, prevents the extension of the depth of the bar, sufficiently for the attainment of the strongest and stiffest form.

2d. The mode of connection between the Z rail and its string piece, makes the latter supply the place of the heavy and expensive chair demanded by the T rail, while the Z rail still enjoys (and in a still greater degree than the T rail) the superior strength and stiffness due to the *depth* of its section.

3d. The same mode of connection gives a continuous support to the upper table, which is not had by any other form of section. And this support not only extends the bearing surface on the wood, but immediately upholds, by an elastic cushion, that part of the head which, in the T and H rails, is so subject to crush, split off and wear away under the wheels; a defect of these sections which will, it is believed, occasion ultimately their entire disuse.

4th. The position of the rail on the *inside* of the string piece, makes the resistance of the rail to the outward lateral thrust of the flanges, as great as that of the string piece itself, a result which cannot be obtained so simply, effectually and economically, by any of the modes of fastening the rail on the *top* of the string piece, which must be employed with the H, or Bridge sections. The push of the flange against the rail, it is well known, is *the* force to be provided against, and this provision is made in the Z rail by the mere effect of its peculiar form; while other rails must be kept laterally in place by auxiliary attachments of iron, the bearing surfaces of which being individually small, must be multiplied expensively and injuriously to the wood, by wounding it at their points of insertion. The fastenings which attach the Z rail to the string piece, are subjected to little or no strain by the side action of the wheels, and are therefore left to the sole duty of maintaining the contact of the bar with its supporting beam, for the preservation of the joint action of the two in resistance to vertical pressure, and securing the correct *line* of the road.

5th. The attachments of the rail to the string piece by a number of bolts passing through both, efficiently resists the tendency to endwise movement in the rail, the prevention of which has heretofore been so imperfectly guarded against. The contraction and expansion of the bar will be provided for, by the elastic yield of the wood at the bolt holes.

6th. The *lining* of the inner edges of the rails at the joints, and the springing of the bars to, and their maintenance in, the curve of the road, will be effectually secured by the horizontal attachments of the rail and string piece. The importance and the difficulty of these adjustments must be acknowledged. The difficulty of making the tops of the bars fall in the same horizontal place, is occasioned by the unavoidable differences in their

heights. The simplest and best way of compensating these discrepancies is, probably, to raise by a detached elevation, the part of the cast chair or joint plate on which each of the uniting rails is to rest, and then the highest of the two bars can, by a proper tool, have its seat reduced by the amount of the excess in its height. This compensation will be required for the Z rail as for all edge rails. But the lateral adjustment of the rails to a line at the joints will, in the Z rail, be effected simply by the screwing of the stem against the string piece; for after this is done the break, if any, which may show itself in the line of the inner edges, must be produced by a difference in the thicknesses of the slender stems of the two contiguous rails, which, (unlike the variation in their heights) must be inappreciably small. In the broad base of the H rail as much room exists for discrepancies in the width as in the height of the bar, and where the lateral alignment of the rails is effected through the lower web, it is very liable to imperfection. The T rail is less subject to this difficulty than the H rail, and the Bridge rail (in consequence of the facility afforded by the hollow in its base, and into which the chair may be made to go up) still less than either; but the Z rail (it is considered) is the least liable to it of all. And in regard to the bending the bars to, and retaining them in, the line of curvature, the advantage of the Z rail over the H, and the Bridge rail, is obvious; both from the more moderate lateral stiffness of the Z rail, and the more direct action and extended resisting surface and adjustibility of its fastenings. The wide bases of the H and ⊓ rails on which their strength and stability mainly depend, render them, it is well known, very difficult to deflect in curves, and next to impossible to prevent them from returning to the condition of *chords* from that of arcs, into which they had been temporarily forced in the construction of the track. The great increase of resistance and concussion in the passage of trains through curves stiuated in this way, need not be demonstrated.

7th. The Z form of the section is the best adapted to bear the action of the wheels, the *coned* part of which, nearest the flange, imparting the most intense pressure, is received immediately by the *stem* of the rail, in which resides the main strength of every rail bar. In the T and H rails the stem is chiefly acted on through the inner ledge of the upper table, with a twisting action, unfavorable to the resistance of the bar; this part of the head suffering also much more severely from the wheel than the outer ledge. In the bridge rail, the inner leg or half of the stem receives the principal action; the outer one being strained to a less extent—an inequality injurious to the strength and wear of the rail.

8th. The simplicity of form of the Z rail section must make the rolling of it easier and cheaper than that of any other edge rail; while the disposition of the fibres and laminæ of the bar is as favorable as possible to strength and the endurance of wear.*

9th. In efficiency, accessibility and capability of adjustment, the fastenings of the Z rail track possess, it is thought, strong points of superiority. The heavy strains and shocks to which railways are subject, and the consequent disposition of the numerous parts composing their structure, to give way and *work*, one with another, renders it very important that the attachments of those parts should be constantly open to inspection and very accessible. Fastening capable of being readily tightened after working loose, such as keys or screw bolts, are preferable therefore to spikes, or simple screws without nuts. But screw bolts used to fasten rails on the *top* of a

* This opinion has been confirmed by that of a professional gentleman of great practical experience, in the manufacture of railway bars.

timber support, must have either head or nut *under* the timber and buried in the ballasting, or filling of the track. In either case the bolt is much more difficult of inspection and adjustment, or removal, than the horizontal bolt of the Z rail.

10th. The new proposed track is finally recommended by economy in the first cost and subsequent repairs, when contrasted with any known form of track of *equal strength of construction.*

In the "comparative table" below, there are three tracks, viz: the Philadelphia and Reading, the Washington branch, and the Balimore and Port Deposit, which are nearly identical with the Z rail track of 45 lbs. per yard, in estimated cost—while three others, viz: the Camden and Amboy, the Newcastle and Frenchtown, and the Wilmington and Susquehanna, fall short of it by from $350 to $750 per mile. The comparison of strength, stiffness and general stability between these tracks and the Z rail track (45 lbs. per yard) which is contained in the columns of that table, from the 8th to the 16th inclusive, will however, justify the claim of greater economy of construction and repairs in behalf of the latter. And if we go to the Z rail track of 35 lbs. per yard, we see an actual saving of $567 per mile in first cost, over the cheapest of the others, and with, *all things considered*, a stronger structure; for the strength of the *track*, as a combination of parts, does not depend solely on the strength of the rail, but largely on the stability of the *connections* of all the parts, in which particulars (as shown in the 14th and 15th columns) the lighter Z rail is seen to be much better provided than the tracks with which it is here compared.

To facilitate the formation of correct opinions in regard to the propriety of the preceding claims to improvement upon existing forms of track, the undersigned has prepared the following tabular view of the principle details of proportion and construction, in a number of the best built railways of the United States. The report jointly made in January, 1838, by J. Knight, Esq. and himself has furnished most of the information here made use of. The strength and stiffness of the several railway bars have been calculated by Barlows's formulæ. The amounts of timber in each track and of iron fastenings, have in some cases been but approximately estimated, but with not much error, it is believed, in any case. The resistances to vertical, lateral and longitudinal movement, are also estimated for each plan with (it is thought) but little variation from those actually obtaining in fact, and in every instance, with the most favorable suppositions, for the several tracks, that their form of construction seemed to justify. In the column of *estimated cost*, is contained an estimate of the expense of constructing each description of track, under the same circumstances and by the same scale of prices (the one contained in the note to page 177;) as if a railroad company, being about to adopt a plan of track, were to exercise its choice among all those here presented, and compare their several costs by the same set of measures of value. But it must be noted, that in order to a fairer comparison than could have been made upon these plans, precisely as they were, in fact, constructed upon the several works to which they belong, there has been added an undersill 3×10 inches, to those which are, in fact, without this support for their cross ties; and a bed of ballasting 8 feet wide at top and 10 feet at bottom, and one foot thick, has been included as a part of the cost of each. With these exceptions, each plan is estimated just it was in reality laid down, (with due allowances for possible imperfections in the information of the undersigned.) The tracks brought into the comparison are those only in which the supports of the rail are of timber, and several important railways more recently laid than those of the table, such as the western and eastern railways of Massachu.

TABLE, exhibiting the comparative weights, strength, stiffness, bearing surfaces, etc., of the edge rails used upon some of the principal railways of the United States, with the relative quantities of timber, etc., employed in the superstructures connected with the several rails, and the estimated cost of tracks per mile.

NAME OF RAILROAD ON WHICH RAIL IS LAID.	Weight of rail pr. yard linear.	Number of tons of rails per mile, per track.	Number of lbs. cast iron fastenings per mile.	Number of lbs. of wrought iron fastenings per mile.	Number of feet of timber, b'd measure, pr. mile in the track as constructed.	Number of feet b'd measure pr. mile, with undersill 3x10 added to the tracks without one	Strength of the rail in tons for a clear bearing of 30 in.	Strength of the rail and string piece combined, for same bearing.	Deflection of rail under the weight by which its *strength* is expressed.	Deflection of rail alone, under weight of eight tons.	Deflection of rail and string-piece combined, under weight of 8 tons.	Bearing surface, in square inches, resisting vertical pressure per running yard.	Surface resisting *lateral* pressure per lineal yard.	Surface resisting *longitudinal* pressure per yard.	Relative *virtual* bearing surfaces having respect to relative *stiffness* of rails.	Estimated cost of a mile of single track on each plan, by the same scale of prices.
New Jersey Railroad, T. rail,	38	59.71	52,800	2,728	63,360	—	4.21	—	.052	.099	—	45	4.7	.40	25	$10,700
Boston and Worcester, T. rail,	38½	60.5	52,800	5,280	50,483	—	4.21	—	.052	.099	—	34½	6.¼	.62	19	10,637
Baltimore and Susqehanna, H rail,	58	91.93	—	16,044	50,688	77,088	12.6	—	.050	.032	—	29.7	3.6	.56	51	11,556
Stonington and Providence, do.	58	91.14	7,040	4,752	82,720	—	12.6	—	.050	.032	—	22.5	3.75	.62	39	11,149
Long Island, do.	56½	89.	5,632	5,280	61,600	—	12.6	—	.050	.032	—	24.	3.	.62	41	10,587
Boston and Providence, do.	55	86.43	7,040	4,752	36,960	63,360	10.32	—	.054	.042	—	24.	3.	.62	31	10,352
Baltimore & Ohio Railroad, do.	52	81.71	10,548	4,102	53,716	—	8.7	—	.055	.051	—	28.	4.	.62	31	10,354
Philadelphia and Reading, do.	45¼	71.	5,910	5,005	55,174	81,574	8.11	—	.076	.075	—	26.9	4.	.62	20	9,451
Camden and Amboy, do.	45	70.71	6,600	2,237	60,555	—	7.65	—	.054	.056	—	19.	3.3	.62	19	9,114
New Castle and F. Town, do.	43½	68.35	1,056	2,259	62,480	—	7.65	—	.054	.056	—	18.	3.5	.62	18	8,736
Washington Branch, do.	40	62.86	9,856	2,112	95,040	—	4.97	18.47	.07	.122	.033	117.	5.	.80	51	9,519
Balt. and P. Deposite, square rail,	40	62.86	—	2,959	118,800	—	2.72	23.68	.118	.347	.045	90.	1.12	1.12	14	9,428
Wilmington and Susq'a, bridge rail,	40	62.86	11,668	2,816	57,200	—	4.58	—	.077	.135	—	26 4/10	5.25	.50	11	8,752
Projected bridge rail track,	45	70.71	5,940	3,696	77,778	—	6.12	13.12	.069	.090	.044	130½	2.13	.65	80	9,927
Do. Z rail,	45	70.71	1,509	4,736	67,760	—	8.	10.41	.035	.035	.027	63⅔	9.12	1.60	100	9,482
Do. do.	35	55.02	1,509	3,269	67,760	—	5.72	9.85	.060	.084	.050	63.	9.12	1.28	41	8,169

setts, the Norwich and Worcester, New Haven and Hartford, etc., have been necessarily omitted for want of specific information respecting them —but it is not believed that their introduction would materially affect the conclusion which the undersigned would draw from the comparison in hand. He has added to the railways of the several companies enumerated, a projected plan of a track in which a Bridge rail of 45 lbs. per yard, is exhibited, with a continuous bearing or string piece; and he designed this track (in which he believes the Bridge rail is perhaps shown as advantageously as possible) for special comparison with the proposed track, in which the Z rail is alike in weight.

The manner in which the several columns of the foregoing table have been calculated, may be sufficiently obvious without explanation, but it will not be amiss to offer some remarks upon the mode in which the 13th, 14th, 15th and 16th were obtained.

The 13th column contains the actual bearing surface of the rail, per running yard, in square inches, on the cross ties or string piece, or both, assuming an average breadth for the ties.

The 14th column shows the number (per yard) of square inches of surface in the timber supports, which resists the *lateral* displacement of the rail; and, in arriving at this particular, the method employed has been to multiply the breadth of each spike or bolt, (brought into action by the lateral push of the wheels) by half the distance to which it penetrates the timber, as in resisting a force applied at one end of and at right angles to it, the fastenings may be supposed to revolve upon the middle of that part of its length, which is grasped by the wood, and consequently only one half of that length opposes itself to motion *in the direction of the impelling force*, while the resistance of the other half is of the nature of a fulcrum of motion.

The 15th column exhibits the surface of resistance to *longitudinal* movement of the bar. In estimating it, this principal was proceeded upon; that the only *efficient* incorporation of the bar, with its substructure of timber, is an attachment of the requisite strength, either in the centre of the bar, where there is *no* movement of contraction and expansion in the iron itself, (and where the rail may and should be rigidly fixed if possible) or if at any other point of the bar attachments are introduced, they must be such, that on moving to and fro with the iron, in its process of longitudinal extension and shrinkage, from alternations of temperature, they will all the time retain their character of *points of resistance*. Now, the only way in which this last condition can be practically fulfilled, is to fix firmly to the *rail*, (so that no motion will exist between them) the bolt or spike, etc., which constitutes the fastening, and to let the movement of the fastening (during the contraction and expansion of the rail) take place *within the wood which it perforates*. And if this motion among the fibres of the timber is to so small an extent, as to leave their elasticity unimpaired by the intermitting compression to which they are subjected, then the perforation containing the fastening will not be enlarged, but will continue to grasp the spike or bolt firmly, and afford (in all states of the bar, as to temperature and length) the desired resistance to movement lengthwise of the track by the action of the trains. Now, in examining the attachments intended to provide against longitudinal movement, in the various rails of the table, it is found that (excepting those of the Port Deposit rail and Z rail) they consist of a fastening either in the middle or at the end of the bar, or at both of these points—where it is in the middle alone, it acts efficiently *to the extent of its surface of resistance*, or where it is at the end alone, it does the same, though permitting more opening of the points of the bars—

but where it is both in the middle and at the end, there is no assistance rendered by the latter to the former, excepting when the bar is at its utmost expansion by heat, at which moment alone, the two fastening will act together; and this is because the end fastening is not firmly attached to the *rail*, but *is* fixed fast in the *wood*, and room is left for the advance and retreat of the end of the bar towards and away from the fastening. For these reasons, I have allowed all the rails (excepting the two just mentioned) the benefit of but one point af attachment in each bar, in calculating their resistance to endwise movement. But the Port Deposit rail and the Z rail, whose fastenings are placed at regular distances apart throughout the entire length of the bar, have all those fastenings attached firmly to the rail, and moving with it under its changes of length; and at the same time they are held by the wood of the string piece with a resistance constant, but sufficiently yielding to permit the elongation and shortening of the rail. All of the attachments of those last rails are therefore permanently efficient, if, as it is believed,* the varying compression of the wood by the spikes and bolts, is not sufficient to destroy its elasticity. These rails are therefore, considered, as complying with the condition above expressed, as necessary to an effectual attachment of the bar to its substructure of wood, by a number of points, with a view to prevent endwise movement. It is true, now, that the H and the Bridge rails are capable of the same sort of attachments, for notches as frequent as may be wished, might be cut out of the feet of the rail, to embrace the shank of the spike. But such a resort would seriously weaken the rail at a every such point of attachment. And as the Z rail has also a foot which may be similarly notched to receive the spike, it would still be enabled to retain its present relative superiority, in regard to a resistance to longitudinal movement.

In the Baltimore and Ohio new track, the resistance to longitudinal movement is estimated by the strength of attachment of the *cross tie*, in the middle of the bar, to the *under sill*, (by means of the treenail) and not by that of the rail to the cross tie, because the former is the *weaker* fastening of the two, and if the bar moved, it would carry the cross tie with it, (as in fact it has done.) The resistance of the ballasting to the movement of the cross tie, is not counted as an aid; for the motion to be guarded against for the preservation of good joints, is so very small, that so loose a material as the filling of the traek, would be totally inefficient to check it. And herein is one reason of the *necessity* of an undersill, and the *advantage* of a string piece, which being closely butted together cannot move endwise; and thus give an abutment to the fastenings for retaining the bar from a similar movement.

The 16th column represents the *ratios* between the virtual or effective bearing surfaces of the several rails; derived from compounding their actual supporting areas with the numbers expressing their deflections under the same load. Of the correctness of this mode of comparison, there can, it is thought be no doubt, as the pressures upon the wood through the iron bars, are *longitudinally* diffused in precise proportion to the relative stiffness of those bars.

* The wood on each side of each bolt or spike hole, will be compressed to an extent proportional to its distance from the middle of the bar. For a rail of about 20 feet long, the movement of the end of the bar, (if confined at the middle) between the probable extremes of temperature, would be a full 12th part of an inch; and this bolt or spike hole would be compressed alternately on each side 1-24th part of an inch, which it would probably bear without permanent enlargement. This would be the *extreme* compression, however, the average being but the one half or 1-48th of an inch, which the wood might well sustain.

The stability of a railway track, like that of any other piece of framing or machinery, must be proportioned to the values of the resistances it presents to the several strains to which it is subjected. This being granted, as it must be, the undersigned feels himself warranted in appealing to the above tabular statement, as furnishing *demonstration* that the track which he has designed, is superior, in all the elements of stability, to any of its predecessors. In bearing surface to withstand *vertical* pressure, it is *twice* as well provided as the track which approaches nearest to it, and nine times better than the one which falls most short of it.

Its resistance to *lateral* movement, is $1\frac{1}{2}$ times that of the track which comes the closest to it, and 8 times that of the one most behind it.

In the counteraction of *longitudinal* motion, it is better than the best of its competitors by nearly 50, and than the worst by 400 per cent.

Now, that improvement in these particulars in the present structures is wanted, the experience of every railroad company must have taught. The best and most expensively constructed railways of the country, cannot be closely inspected without it being perceived, that the connections of their parts are too weak to withstand the action of their locomotive machinery. To a greater or less extent, in all those which have come under the examination of the undersigned, the wooden supports are crushed, the iron rails forced aside, and the joints either entirely closed or too widely opened. Spikes, bolts, and other fastenings frequently give way, and where the maintenance of an accurate adjustment of the track is aimed at, much expense of material and labor is incurred in replacing them; while the expedients resorted to, for restoring the deranged adjustments, cripple the timber, and convert the originally handsome structure into an unsightly piece of patchwork. There may be lines of railway, which have, in a measure, escaped these derangements; but has the trade and tavel upon them been as yet very trying?

There certainly cannot well be too much strength given to a rail track, provided a sufficient elasticity is preserved to relieve to a certain extent the concussions, which are destructive of the machinery. In this latter view, wood should be preferred to stone, as a support for the rails, although stone would afford theoretically the most strength in the connections.

In the 8th column of the table, showing the weight in tons that each rail will bear, it will be seen, that while the T rails of 38 lbs. per yard are quite weak, as well as the Bridge rail of 40 lbs. per yard, and still more the Square rail of the same weight (to which last, the string piece is indeed absolutely necessary) those of the H pattern, (9 in number) varying from 40 to $58\frac{1}{2}$ lbs. per yard, exhibit a great degree of strength for their respective weights—3 of them reaching $12\frac{6}{10}$ tons, and 1 of them $10\frac{1}{3}$ tons—4 of them from $7\frac{2}{3}$ to $8\frac{2}{3}$ tons, and the lightest of them 5 tons. It must be observed of these rails, that in estimating the strength by Barlow's rules, the whole breadth of the lower web was used in the calculation, although that writer intimates a doubt founded upon one of his experiments, whether in such sections, the outer portions of the base add much to the strength of the bar. Admitting, however, that they do (notwithstanding the professor's doubt) contribute fully as much as the calculation supposes, it is considered that it would be much better to submit to a reduction of strength in these bars, by removing some of the metal from the lower web, in order to strengthening with it the upper table, which is disproportionately light.* But then, as the breadth of base in these bars is not too great for stability,

* The English Engineers seem to be verging towards a preference of the Bridge section over the T and H sections, on account of the destructibility of the upper table of the latter forms of bar.

it could not be reduced without reducing also the *height*, and this again would diminish their strength and stiffness. It is true that the present apparent strength of these rails is superfluously great, a strength of 8 tons (which the Z rail has independent of its string piece, and 10½ with it) being all sufficient. No change, however, which could be made in the proportions of the H rail, as exhibited in the bars in question, would make its top as well able to endure the wear of the wheels as that of the Bridge rail. The latter indeed is neither so strong nor stiff a form of section, but as has been said before, will prove practically the best rail of the two, and between it, therefore, and the Z rail, the undersigned believes that the question lies. The superior strength and stiffness of the Z rail, then, suffering no drawback from the weakness of its upper table, which is as well or better supported than that of the Bridge rail, should it not obtain the preference, unless some other objections can be established against it, which overbalances its advantages in those particulars?

Here, then, appears the proper place to notice some of the objections to the Z rail, which may occur to others as they present themselves to the undersigned while maturing his plans.

It may strike those who examine it, that the dependence of the Z rail on the string piece for *lateral* support and maintenance in its upright position is objectionable. But when it is considered that on the string piece it is equally dependent for *vertical* support, like any other rail of continuous bearing on wood, the difficulty seems to disappear. The Z rail indeed *hangs* by its top on the inner edge of the string piece, just as the common plate rail rests thereon. The Z rail may, in fact, be regarded as an iron plating of the top and inside of stringer; as long as the latter retains its stability, so long will the former—and we know that the stringer of the plate rail track would stand very well, if it did not crush under the weights from which its thin bar protects it so poorly. But it will be said, that the Z rail does not bear on the string piece alone, but also on the cross tie. True, and if the latter bearing acted, or sustained the whole weight independently of the former, the string piece would then perform the office of a simple side support. This it would, indeed, be entirely competent to; but in fact it must of necessity bear the vertical pressure of the rail also, in consequence of the *intended* insufficiency of the tie, to sustain it unaided. The bearing area upon the tie is but 9 square inches per running yard of rail, a surface experimentally known to be too small to resist compression in the hardest woods we have.* Should, then, the bearing of the rail, through defective fitting of the parts in construction, be thrown at first on the tie, it will soon become compressed under the travel, so as to bring the top bearing of the rail on the stringer into action; and where the latter bearing is perfect in the first instance; but afterwasds withdrawn by *shrinkage of the timber*, the rail gradually indenting the tie as the stringer recedes, will follow the latter and maintain the constant harmony of the two bearings. This expected result depends upon such simple and obvious principles of mechanical action, that the undersigned cannot feel hesitation in his confidence of its occurrence: The amount of shrinkage in the string piece, will not exceed about ¼ of an inch in extreme cases, and this much, the tie will assuredly compress. The cast iron plate at the joints, extends the tie bearings there, but not more than the rail requires from its greater weakness at those points.

There are, then, the best reasons to believe, that the rail and string piece will act together as a single beam, whose proportional height and width

* The *locust* ties upon the new track of the Baltimore and Ohio railroad, when the bearing area is 28 inches per running yard, have all become more or less indented by the base of the rail.

and connection with its supports, will give it all the stability of position that can be desired. The string piece being fitted close and confined in the notch of the tie by a treenail, it is proposed to compensate for the small shrinkage of the former, by driving a thin wedge between it and the outer shoulder of the notch, so as to keep the gauge of the track from widening. Any other form of rail resting on top of a string piece, would equally indeed require this adjustment. The impression, then, that the dependence of the Z rail on its string piece is, in reality, greater than that of any other section of bar, supported by a continuous bearing, will, it is believed, be removed by reflection from the minds of those who may naturally recieve it from a slight examination of the subject, and their ultimate conclusion, it is thought, will be, that the Z rail holds, on the other hand, the best possible position with respect to the timber with which it is connected, and that it will suffer no more from the decay of the wood than will any other rail, upheld in any other manner by a similar material.

The 6th column of the preceding table, exhibiting the quantity of timber in each track, will show that the advantage of a very limited employment of wood, supposed to belong to the heavy class of rails, is not, in fact, realized by them; as with two of the most weighty and best laid of them, viz: the Long Island and the Stonington rails, there is employed from 60 to 80,000 feet, board measure, per mile—the average between which, would be come up to by the Boston and Providence, and Baltimore and Susquehanna rail, if they were furnished, like the other two, with an undersill. The able Engineers who planned these railways, have, in the two first mentioned, which were the latest executed, shown their approval of the use of about that quantity of timber (70,000 feet, board measure) per mile, and with much less, no stable construction can be effected, even with the use of the heaviest iron. The quantity of wood in the Z rail track is about 68,000 feet, being slightly within this limit. The projected track for a Bridge rail of 45 lbs. pr. yard, has 78,000 ft. Both of these rails have a continuous bearing upon string pieces, yet they average very little more timber per mile than the heaviest rails with detached bearings. In fact, there is a proportion, and that not an inverse, but direct one, which should be maintained between the weight of the rail, and of the frame work connected with it. Nor in giving a continuous bearing to the rail, need the quantity of timber be necessarily increased; for the undersill may be proportionably lightened and the number of ties diminished, if a string piece be employed. The existing prejudice against the string piece, founded on the idea that it encumbers the track with an extra quantity of a perishable material, must therefore give way, and the continuous timber bearing will come into permanent favor. If, moreover, the hopes now strongly felt, of extending greatly the durability of wood, by the application of the process of Kyan and others, be realized, the sole valid objection to the use of timber in railways will be removed and all its advantages be enjoyed without a drawback. Yet, as wood is destructible not by rot alone, but also by *wear and tear*, it will still be necessary to guard against these latter agents, by providing abundant surfaces of resistance to the several strains upon the framing, and the structure which best accomplishes this object will ultimately and justly be the favorite.

The undesigned now respectfully commends the subject of the preceding remarks to the enlightened judgment of those to whom he has addressed them. In treating of his own invention, he has necessarily, and as he hopes not altogether unprofitably to himself and others, been led into the discussion of several points of general interest respecting the construction of railway tracks, and this has extended his observations to a greater length than he designed. He cannot better conclude them than by an ex-

pression of the cheerfulness with which he will abide by the decision which the Civil Engineers of the United States shall pronounce upon the merits of the plan he has presented, and he asks the favor of them to communicate to him, as early as their leisure will permit, their individual views of its claims to favor and adoption.

BENJ. H. LATROBE,
Baltimore, December 10th, 1840. *Civil Engineer.*

STEAM ENGINES.—We have received a copy of the annual report of the canal commissioners of Pennsylvania. Among the documents threto appended, is the report of the superintendent of motive power on the Philadelphia and Columbia railroad, in which an engine built by Mr. Ross Winans, of this city, is spoken of in the most flattering terms, which applies not only to the particular engine, but to the class of engines built by Mr. Winans. We extract the following from the report: "In addition to the different engines of the ordinary construction purchased by the undersigned is one built by Ross Winans, of Baltimore, which, as well as others, was contracted for by a resolution of the board, previous to the date of my last report. The general principle upon which this engine is constructed, is similar to the one which, by the order of my predecessor, has been placed on the road near a year before my appointment. It is, however, entirely different in its proportions.

"This engine was constructed by special orders, as an experiment in the use of anthracite coal as a fuel to generate steam; and on trial, has met all my anticipations. It is very large and heavy, with more than double the power of any other machine on the road. It burns anthracite coal exclusively, and from the additional space of fire box, obtained by its increased size, has advantages in the use of that article, which is not and which cannot be possessed by any orther plan of engine. It is intended exclusively for the transportation of heavy trains of burthen cars. It will haul double the ordinary train, but owing to its great weight, must be run very slowly over the road."

We have understood that this engine rests its entire weight on *four propelling* wheels, each wheel supporting about the same weight as each one of the *two propelling* wheels of the largest class six wheel engines on the Philadelphia and Columbia road. The engine last built by Mr. Winans, and which we have before noticed, is still more powerful than the one spoken of in the report; but having overcome the difficulty that has heretofore been deemed insurmountable, of placing eight wheels under his engine, and connecting the motive power with all of them, so as to get the adhesion of the entire weight, without having a weight on any one wheel, which is oppressive to the road. The engine now furnished weighs 19 33-100 tons, when in running condition, and is mounted on eight propelling wheels, which divide the weight equally among them, putting 2 42-100 on each wheel. The passenger engines of Norris' construction, in such extensive use, weigh about 10 tons when in running condition, but as they have only two propelling wheels, the greatest adhesion which they can render available is that resulting from 6 70-100 tons resting on the driving wheels, which is but little more than one-third the adhesion obtained by Mr. Winans' eight wheel engine, while the weight on each driving wheel of the Norris is 3 35-100 tons, nearly a ton more than the weight on each wheel of the eight wheel engine. The power of every locomotive engine is limited by the greatest adhesion of its wheels on the rails; the adhesion is directly as the weight resting on the propelling wheels collectively. The greater the weight bearing on any one wheel the more destructive to the road. The greatest economy in transportation results from

the use of the most powerful engines that can be employed, consistent with the strength, and character of the road, on which they are to run; hence the advantages of increasing the number of propelling wheels.

An account was published a few days since in a Philadelhia paper of a gross load of 481½ tons being drawn over the Philabelphia and Reading railroad by an engine built by Messrs. Baldwin, Vail and Husty, the weight of which is stated to be 11 92-100 tons, and the weight on the driving wheels 6 30-100 tons. As this is less than one-third the weight on the driving wheels of Mr. Winans' eight wheel engine, which has been shown to work to the full extent of its adhesion, it follows that it would be capible of taking over the Reading road three times the amount of the load above named.

The report above mentioned states a fact which gives to Mr. Winans' engine great recommendation. It is with reference to fire from locomotive engines. Extract from the report: "But I am constrained to say, that I am now satisfied that public opinion has always placed a mistaken estimate on the security in engines, the fuel of which was exclusively mineral coal, against firing property in the vincinity of the road. One year's experience has settled that question in the mind of every one who has paid any attention to the subject. It is true, if all the engines on the road were constructed on the same plan as those made by Ross Winans, of Baltimore, with vertical boilers and tubes, or flues, and a constant or uniform draft, then there would be no danger from fire. But with the ordinary engine, the draft of which is created by the exhaust steam of the engine itself, there is nor can be no security against fire."

BALTIMORE MECHANICS.

In our paper of the 19th ult. we touched briefly on the ingenuity, skill and industry of the mechanics of Baltimore, and incidentally noticed the locomotive engine constructed by our townsman, *Ross Winans*, with a promise that, at a future day, we would give a more minute description of the machine, with its advantages over engines of ordinary construction. We now proceed to comply with our promise.

The engine is constructed with a view to adapting it to the purposes of transportation. Its weight, when in running condition, is nineteen and a third tons, equally distributed on eight wheels, all of which are driving or propelling wheels; hence the adhesion of the entire weight of the machine is made subservient to its tractive power. The boiler is of the upright description, with vertical tubes, is peculiarly adapted to the use of coal, has 650 tubes and 20 square feet of fire grate. The cylinders are 14¼ inches in diameter and 24 in stroke. A highly important feature of the machine is, that while it has eight propelling wheels and is admirably adapted to the traversing of curves of the shortert radius common on railroads, (say 3 to 400 feet,) it is simple, compact and permanent in its construction to a degree that would scarcely be deemed possible without an inspection of the engine; it having a decided advantage in this respect over the generality of engines in this country, having *one and two pairs of drawing wheels only.*

The appearance of the engine is remarkably plain, pleasing and imposing, while it is entirely without ornament, except the comeliness of its outline, and the superiority of its workmanship, which is of the very best description. Among the practical advantages which this engine has, compared with the best of others known to the public, are the following: The adhesion is double, and consequently the load taken, or the amount of business performed is double, while the weight on any one wheel is not

more, and in most cases considerably less than any engine possessing half its power. Thus the expense of men in attendance on the engine and train is reduced to one half in proportion to the work performed, and a relief is afforded to the road which will result in the diminution of its repairs. The unusual power of the engine and amount of work performed by the per day produces a material decrease in the amount of fuel required for a given amount of goods transported. The great weight and strength of the various parts of the machine, (which is permitted by the weight being equally distributed on so many bearing points on the road,) will manifestly diminish the repairs of the machine in proportion to its useful effect.

Again: this description of engine will enable roads with heavy grades to be worked with an efficiency which has not before been obtained, for reasons which will be manifest to engineers. The engine in question was constructed with particular reference to the character and purposes of the Baltimore and Ohio Railroad, with a view to affording that company the means of testing fully and practically on their road the great advantages which were expected to result from the employment of engines of such power, provided the weight could be equally distributed on eight *propelling* wheels, combined with a simple, permanent and practicable arrangement and mode of causing the engine to traverse the numerous curves of that road with the requisite facility and safety. This Mr. Winans has accomplished to a degree, which few, if any besides himself, believed possible until the engine was put on the road, so that little more, if any thing is desirable in that respect.

The several trips which Mr. Winans has made with the engine to Harper's Ferry and back with heavy loads, to ascertain whether all was as he wished previous to his calling the attention of the company to the subject, have, so far as they go, fully supported the most favorable opinions entertained in reference to the advantages and saving to result from the employment of such class of engines. Mr. Winans has now offered his engine to the railroad company, for the purpose of enabling them to test fully its properties, and to compare its advantages and economy in the working of the road with those of the several descriptions of the most approved plan of engines known in their employ, previous to the company's taking measures to procure the additional engines required on their completion of the road to Cumberland, which it is expected will be accomplished in the next eighteen or twenty months.

This offer of Mr. Winans the company will no doubt most cordially embrace, as it comes most opportunely to enable them to complete the comparisons between the most promising engines extant, which they have been pursuing for several years, to enable them to act understandingly in a matter of much importance to the successful and profitable working of the road as that of selecting the plan of engine best suited to its requirement.

NEW LONDON, NORWICH, AND WORCESTER RAILROAD.

We publish below the proceedings of a meeting of the citizens of New London, convened at the City Hotel on the 25th ult., for the purpose of conferrimg on the subject of extending the Norwich and Worcester Railroad to this city. We understand that in pursuance of the wishes of the meeting, as expressed by a vote, the Committee proceeded to Norwich, and had an interview with the directors of the company, by whom they were received with kindness and cordiality. In the course of a friendly and frank discus-

sion of the subject, the directors gave the Committee to understand that they were not at present prepared to extend the road, but if, upon further trial, it should be found that the Road, as at present established, will not afford that accommodation to the public which it was designed to afford, they will then be happy to confer with the committee, and to meet the views of the citizens of New London as expressed in the resolutions published below.

The committee appointed by the meeting will continue organized, and our citizens may be assured, from the character of the gentlemen composing it, that they will be watchful of the interests of New London, in case that an extension of the road should become necessary, while they will avoid throwing any obstacle in the way of our Norwich friends, who deserve much praise from this community for their perseverance in bringing so near to perfection a work, which to us, as well as so the whole public, is even in its present state, of great and increasing value and convenience. We can assure our neighbors of Norwich that they have no unkind feelings to meet on the part of New London in perfecting the work at its present terminus, and it is only in case that this should be found impracticable that the citizens of New London would wish to move in the matter.

The inhabitants of the city of New London having convened, in pursuance of public notice, on Thursday, the 25th ult., at the City Hotel, for the purpose of conferring upon the subject of continuing the Norwich and Worcester Railroad to this city, the meeting organized by appointing Ebenezer Learned, Esq., Chairman, and George C. Wilson, Esq., Secretary.

On motion of Gen. Isham, the following resolutions were presented, and after being ably sustained by him and by Thomas S. Perkins, Esq., were unanimously adopted.

Whereas, it is understood by this meeting, that the directors and company of the Norwich and Worcester Railroad contemplate the extension of their road from its present termination in the city of Norwich, to some other convenient point upon the waters of Long Island Sound; and whereas, it is also understood, that the citizens of Norwich accede to the contemplated extension of the road, it is therefore

Resolved, That Messrs. Jonathan Coit, Francis Allyn, Charles A. Lewis, Noyes Billings, John Brandegee and Acors Barnes be and hereby are appointed a committee to communicate with the officers of said company, and to procure such information as to their plans and views in relation thereunto as said committee may be able to obtain, and to communicate such information to the inhabitants of this city.

Resolved, That this meeting do highly appreciate the enterprize and perseverance of the citizens of Norwich in thus far effecting the important work above referred to; and we do express our firm conviction that an extension of the road to New London will be advantageous to that city, as well as to this, and that such an extension would greatly increase the income of the company.

Resolved, That the gentlemen composing the above mentioned committee be requested to ascertain the necessary facts with the

least possible delay, and if they deem it expedient, to proceed immediately to Norwich, Worcester and Boston, and that they be authorised to communicate to the officers of the Norwich and Worcester Railroad Co. and to such other persons as to the said committee may seem expedient, the above resolutions, with full assurances of a disposition on the part of the inhabitants of this city to co-operate in extending the road of said company to this city should said company propose so to do.

Attest, EBENEZER LEARNED, *Chairman*,
GEORGE C. WILSON, *Secretary*.

New London, Feb 25, 1841.

ACCIDENTS ON RAILWAYS.

To the list we gave last week of railways, the miles run, and accidents which have occurred, we have to add the returns of the following :—

The Great Western has run 29,200,000 miles, carried 1,520,000 passengers, without any accident, fatal or otherwise, to a passenger, from its opening, 2 years and three months.

The Brandling Junction has run 92,876 miles, and carried 617,000 passengers without any fatal, and only two trifling accidents, neither of which prevented the parties from going about their usual business, in 12 months, to the 5th instant.

The Bolton and Lehigh has run 223,480 miles ; carried 674,870 passengers in $9\frac{1}{4}$ years, to the 15th September, with the following accidents :—one passenger, attempting to get into the train when it was starting, got his foot bruised ; another, who had got upon a waggon going off with the train, was thrown off and had his arm injured ; a third had a slight contusion occasioned by a collision ; and a fourth was killed by jumping off a train going at full speed, in consequence, as it was believed, of his being intoxicated. The only accidents attributable to the railway are obviously the "slight contusion," and the iujured arm.

The Dundee and Arbroath, opened October the 8th, 1838, (now 23 months) has, to the 1st September inst., carried 378,043 passengers, (the miles run not stated) with the following solitary accident, namely, the breaking of the leg of a passenger who had, contrary to the regulations, got into the luggage waggon.

The Arbroath and Forfar was opened January the 3rd, 1839, (now 20 months) and has run 59,000 miles, and carried 175,000 passengers, to September 10th. One accident only has happened ; that is, a passenger broke his leg by jumping off the train while in motion.

Thus are added to our former list, from these five railways, only one of which is a large passenger line, 3,365,000 passengers carried, and on four only of the lines 29,575,000 miles run, without one fatal accident, and only two slight bruises fairly attributable to the railways ; for we repudiate all accidents which the drunken or headstrong ways of men, violating orders and rules, bring upon themselves. The account, therefore, will stand thus ; about 256 millions of miles have been run, and 14 millions of persons carried, with only two fatal accidents from the railway system.